MSC-KA-H-68-2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO APPLICATIONS PROGRAM

Quarterly Status Report No. 1

For period ending September 30, 1968

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

FOREWORD

The NASA's first step toward manned space flight was the Mercury program, which was concluded in 1963. The program demonstrated that a manned spacecraft could orbit the earth, reenter, and land safely. It also provided man's first experience in extravehicular activity. The Gemini Program, which ended in 1966, showed that man could effectively operate for up to two weeks in the space environment and provided experience in maneuvering, rendezvous, and docking. In the early 1960's, the United States adopted a national goal of landing a man on the moon and returning him safely to earth before the decade was out. At that time, the already existing Apollo Program was shifted from a circumlunar expedition to a lunar landing endeavor.

The Apollo Applications Program is NASA's next significant phase in the development of future manned space flight programs. The Apollo Applications Program is designed to investigate man's role in longer term space exploration and to effectively exploit space to meet man's needs on earth. The program is built upon flight experience, ground facilities, and trained manpower developed in the Mercury, Gemini, and Apollo programs. Maximum economy is achieved through the use, modification, and expansion of present Apollo system capabilities. The basic objectives of the Apollo Applications Program are:

1. Long-duration space flight for up to 2 months

2. Scientific investigations in earth orbit

3. Applications in earth orbit

4. Effective approach to development of future manned space-flight programs

CONTENTS

FIGURES

ACRONYMS

AAP	Apollo Applications Program
AAPO	Apollo Applications Program Office
A-C	Allis-Chalmers
ACE-S/C	acceptance checkout equipment/spacecraft
ARS	atmosphere revitalization section
AS&E	American Science and Engineering
ATM	Apollo telescope mount
BRM	base line reference mission
CCA	contract change authorization
CCP	contract change proposal
CM	command module
CMG	control moment gyro
CSM	command and service module
CY	calendar year
DAP	digital autopilot
ECS	environmental control system
EIS	end-item specification
EPS	electrical power system
EVA	extravehicular activity
GAEC	Grumman Aircraft Engineering Corporation
GE	General Electric
GFE	Government-furnished equipment
GSE	ground-support equipment

GSOP	ground systems operation plan
ICD	Interface Control Document
KSC	Kennedy Space Center
LM	lunar module
LM-A	lunar module as adapted to the AAP
MDA	multiple docking adapter
MDAC	McDonnell-Douglas Astronautics Corporation
MIT/IL	Massachusetts Institute of Technology/Instrumentation Laboratory
MMC	Martin-Marietta Corporation
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
NR	North American Rockwell
NRL	Naval Research Laboratory
OWS	orbital workshop
P&I	performance and interface
PBR	preliminary base line review
PCR	preliminary configuration review
PDR	preliminary design review
PRR	preliminary requirements review
RCS	reaction control system
RDX	a high explosive
RID	review item discrepancy
S/A	supplemental agreement
S-IVB	Saturn IVB

SLA	spacecraft-lunar module adapter
SM	service module
SOW	statement of work
SPS	service propulsion system
vhf	very high frequency

SUMMARY

During the third quarter of calendar year 1968, a new system of work planning and assignment of responsibility was initiated. The system consists of contractual-type agreements, or work packages, which specify work performed, products delivered, and resources utilized between Center organizations. Payload overweight was a major problem during the quarter. Mission AAP-1/AAP-2 had significant changes base lined into the flight profiles as a result of the problem. The most significant event during the quarter was the final authorization for the transfer of management responsibilities for the airlock and lunar modules from the Manned Spacecraft Center to Marshall Space Flight Center. The actual transfer of specific responsibilities will not be implemented until after the beginning of the fourth quarter.

The quarter's activities are discussed under six topics: Management Activities, Contracts, Mission Planning, Experiments, Systems, and Engineering and Operational Support. Management activities were largely involved in preparation of the work packages. Contractual activities were typically involved in cost and schedule summaries, review of contractor documentation, and preparation for milestone hardware reviews. Mission planning efforts were concentrated on base lining changes into the AAP-1/AAP-2 flight profiles. Experiments efforts were typically involved in testing of experimental hardware and feasibility studies. Systems efforts were typically involved in operation testing of hardware, feasibility studies, and systems integration. Engineering and operational support activities were generally involved in establishing operational base lines.

MANAGEMENT ACTIVITIES

The most significant management activity during the third quarter was initiation of the Manned Spacecraft Center (MSC) work package management system on July 1. The system was established by Center directive to encompass all work done at MSC into contractual-type agreements which would cover work performed, products to be delivered, and resources to be utilized. The agreements provide a method for clear assignment of responsibility and for work planning. Quarterly status reports on the work packages will provide an information system to all levels of Center management on both past and projected utilization of Center resources.

Each Center program developed separate functional work packages for the tasks being performed in support of a program or when the work of a single organizational element was significantly different in objectives, products, or timing from any other task being performed. Each work area was assigned an identifying three-digit work code. Additional digits were assigned to identify the various parts of the work structure within the work area.

Because of the diverse functions performed within MSC, a standard work package format was considered impractical. Only the form used for the cover sheet is uniform. It provides information for identification, authorization, and content. The content is divided into scope of work, performance characteristics, and resource allocation. These topics and their subdivisions, which are shown on the cover page, identify and suggest items which may be documented and agreed to by both performing and sponsoring organizations. The performer listed on the cover page is directly responsible for the details of the work package and for maintaining current status.

The internal Apollo Applications Program (AAP) work package effort was defined in terms of its objectives and products. This division necessitated six work packages:

Program Management

Command and Service Module Project

Lunar Module/Apollo Telescope Mount

Airlock Module Project

Experiments Project

Future Missions Project

Since the objectives discussed in the scope of work of each of these packages are achieved by the functional offices of the AAP, their support to each of the projects is discussed separately in each of the work packages. All of the internal AAP work packages have been approved and distributed.

External work packages appropriate to the AAP responsibilities were anticipated with:

Engineering and Development Directorate

Flight Crew Operations Directorate

Flight Operations Directorate

Medical Research and Operations Directorate

Science and Applications Directorate

Reliability and Quality Assurance Office

Administration Directorate

Computations and Analysis Division

Flight Safety Office

Program Control and Contracts Division

Office of the Director

These work packages are in various stages of negotiation.

A significant change in MSC AAP responsibility and objectives was initiated toward the end of the quarter. On September 16, the Administrator of NASA authorized the transfer of management responsibilities for the design and development of the AAP LM and airlock hardware activities from the Manned Spacecraft Center to Marshall Space Flight Center (MSFC). However, the definition and complete transfer of specific responsibilities will not be completed until after the beginning of the fourth quarter.

There have been no changes in the basic structure of the Apollo Applications Program Office (AAPO) organization, which is illustrated in figure 1.

The AAP intercenter coordination panel activities are continuing. There have been no additions or deletions of panels or subpanels during the quarter. (See fig. 2.)

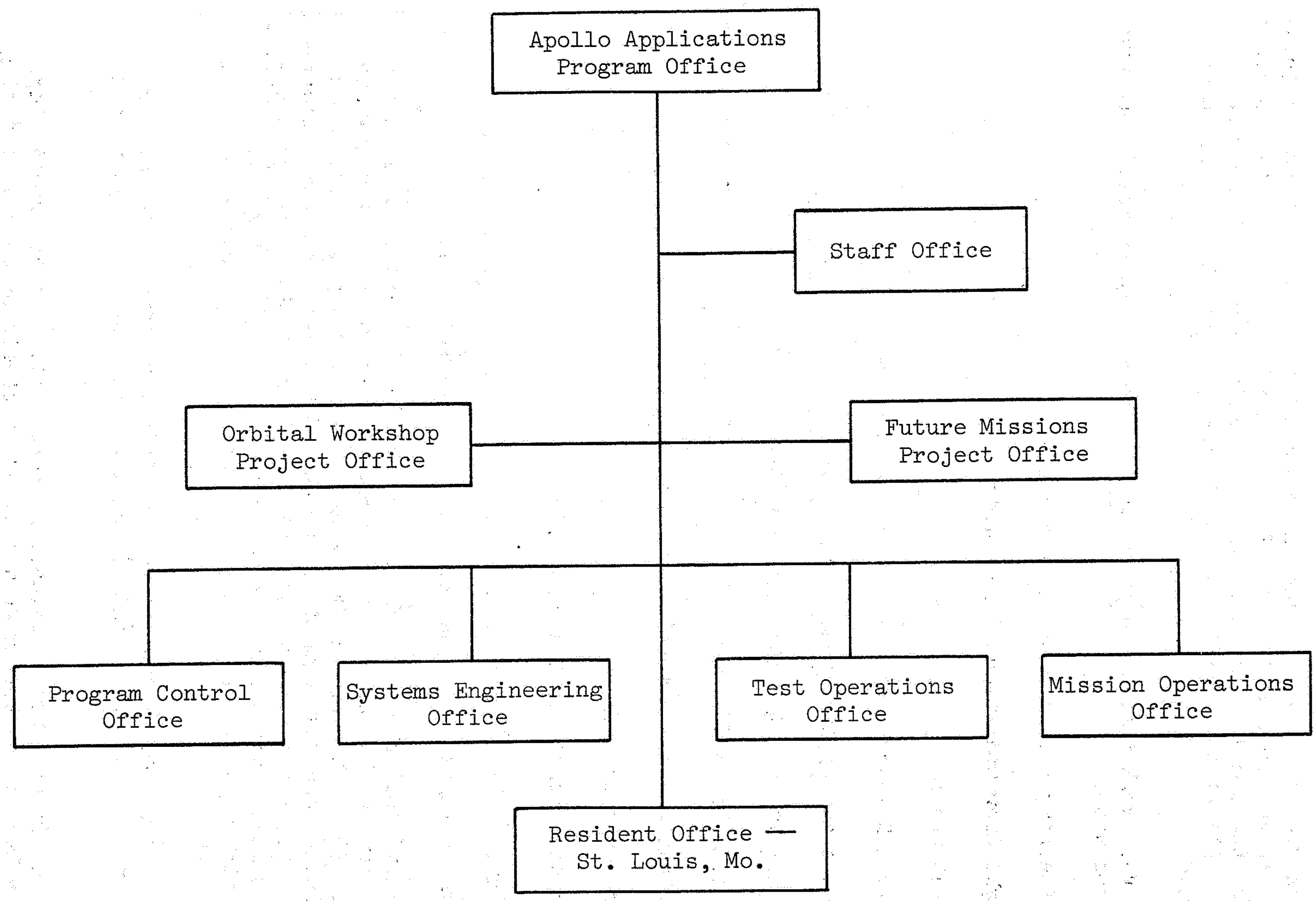

Figure 1.- Organization of the Apollo Applications Program Office.

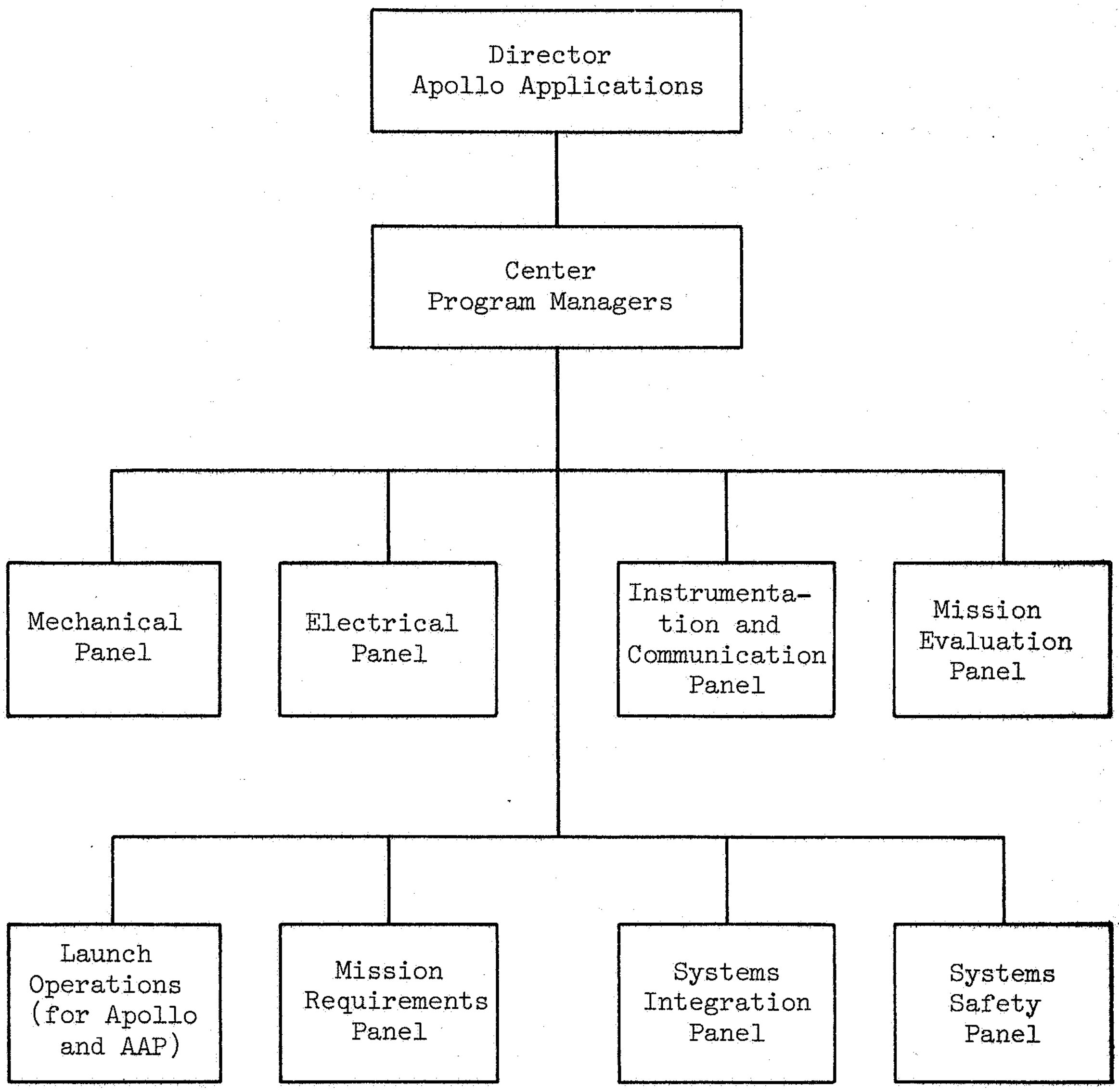

Figure 2.- Apollo Applications Program intercenter interface panel organization.

CONTRACTS

ALLIS-CHALMERS (NAS 9-8639)

On July 3, 1968, MSC AAPO received authorization from NASA Headquarters to enter into a contract with Allis-Chalmers (A-C) for flight qualification of the NASA 2-kW fuel cell "for future long-duration manned missions." Specific instructions were: (1) solicit a proposal for a cost-plus-fixed-fee effort, (2) issue a letter contract beginning June 1, 1968, to be definitized by November 30, or prior to exceeding 50 percent of the total estimated program costs, and (3) include pre-contract costs determined to be "allowable (allocable and reasonable)."

A letter contract was signed on July 25 based upon an abbreviated proposal indicating general understanding on the part of A-C. A definitive proposal for the complete program was received at MSC on August 12, and contract negotiations were conducted on September 24 through 27. The program recommended in the proposal evaluation memorandum, which was to meet only the 1500-hour fuel cell requirements of the AAP Missions 1 through 4, was agreed upon. The technical status of the program will be reviewed during a coordination meeting to be held at A-C on October 1 through 4.

Major contractor efforts during the third quarter have been directed toward hardware end-item qualification and their integration into the spacecraft. A program review was conducted at the A-C facility on August 21 primarily to familiarize AAPO management with hardware design, development status, and planned followon activities.

THE BENDIX CORPORATION/INSTRUMENTS AND LIFE SUPPORT DIVISION (NAS 9-7689)

On February 19, 1968, a cost-plus-fixed-fee contract to Bendix Instruments and Life Support Division was authorized. Bendix was to design, develop, and qualify cryogenic gas storage systems for long-duration AAP missions. Ten tanks were to be delivered for flight use on early missions. Additional tanks are being contemplated for AAP-3, AAP-3A, and AAP-5.

Although contract changes, reprograming base line requirements, and long lead-time purchase items have impacted the total program, significant accomplishments have been made during the quarter. The accomplishments include: (1) 90-percent completion of drawing and specification release, (2) 50-percent completion of preliminary component development evaluation, (3) successful pressurization of a pressure vessel to design proof and burst levels, (4) testing of a structural model dewar with sinusoidal and random vibrations, (5) testing of a prototype dewar for thermal performance, and (6) a program review at the Bendix facility on August 20 to familiarize AAPO management with hardware design, development status, and followon activities.

GENERAL ELECTRIC COMPANY (NASw-1721)

The General Electric (GE) effort for the AAPO at MSC was first obtained as a modification to the Apollo/GE Contract NASw-410 for the period from August 1, 1967, through June 30, 1968. The modification provided engineering support for the AAPO test operations and base line configuration engineering. Extension of this GE support was obtained as a task to the Headquarters/GE Contract NASw-1721 for the period from July 1 through December 31, 1968.

Procurement action was started during the last week of September 1968 for a new MSC/GE contract with a period of performance from January 1 through December 31, 1969. On this contract, GE will support the AAPO test operations and program control, reliability and quality assurance, and related engineering for acceptance checkout equipment/spacecraft (ACE-S/C).

GRUMMAN AIRCRAFT ENGINEERING CORPORATION (NAS 9-6608)

On June 1, 1968, a letter amendment was issued to the Grumman Aircraft Engineering Corporation (GAEC) to contractually cover 4 months of effort toward the preliminary design review (PDR). The letter amendment was definitized and issued by August 5 for performance through September 30. However, a constraint to maintain the manpower level at 400 men per month necessitated postponing the PDR from the end of September until mid-October. A contract modification was issued on August 23 to fund GAEC effort through the PDR, which was scheduled for October 16.

Significant events during the quarter include the first LM-A Systems Technical Management Meeting held at MSC on July 2. The main topics of discussion were:

1. Replacement of the LM probe with a drogue

2. Alternatives for making LM-A systems less active after docking with the orbital assembly

3. Retention of the manual LM-A docking capability

The relative position of the LM on the orbital assembly is shown in figure 3.

At the second LM-A Systems Technical Management Meeting held on August 15, the discussion centered around the redesigning of the crew provisions storage module. Inside height had been increased to 27 inches to allow proper orientation of the Naval Research Laboratory (NRL) and the American Science and Engineering (AS&E) experiment packages. The deletion of the atmosphere revitalization section (ARS) from the environmental control system (ECS) was also discussed at the meeting. The GAEC later received formal direction to delete the ARS.

On September 18, GAEC presented their initial Mission AAP-3/AAP-4 stowage lists. The presentation included contractor-furnished equipment supplied by GAEC and Government-furnished equipment (GFE). The initial stowage lists will be correlated with other stowage lists to form the final list for the spacecraft.

In support of the PDR, the contractor has produced documentation such as safety specifications, configuration plans, reliability and quality assurance specifications, and manufacturing procedures. These support documents have been in review at MSC for preparation of comments to be presented at the PDR.

The transfer of LM management activity from MSC to MSFC is scheduled to take place shortly after the PDR. Action has been initiated by MSC, in conjunction with MSFC, to prepare the statement of work and manpower requirements for continuation of GAEC effort after the PDR.

MARTIN-MARIETTA CORPORATION (NAS 8-24000)

On July 2 and 3, Martin-Marietta Corporation (MMC) representatives were at MSC to negotiate a followon contract (modification MSC-3 to contract NAS 8-24000) for payload integration. The period for the contract negotiated is July 1 through December 31, 1968. Approved contractual documents were distributed on August 9. MMC is required to furnish specific products such as plans, criteria documents, analyses, implementation packages, and other documentation necessary to reflect program requirements. All activity is initiated by technical directives issued from the program office.

Technical directives were issued to MMC on a priority basis within the established funding constraints. During the third quarter, task schedules, operation handbooks and plans, requirements documents, and concept studies have been implemented.

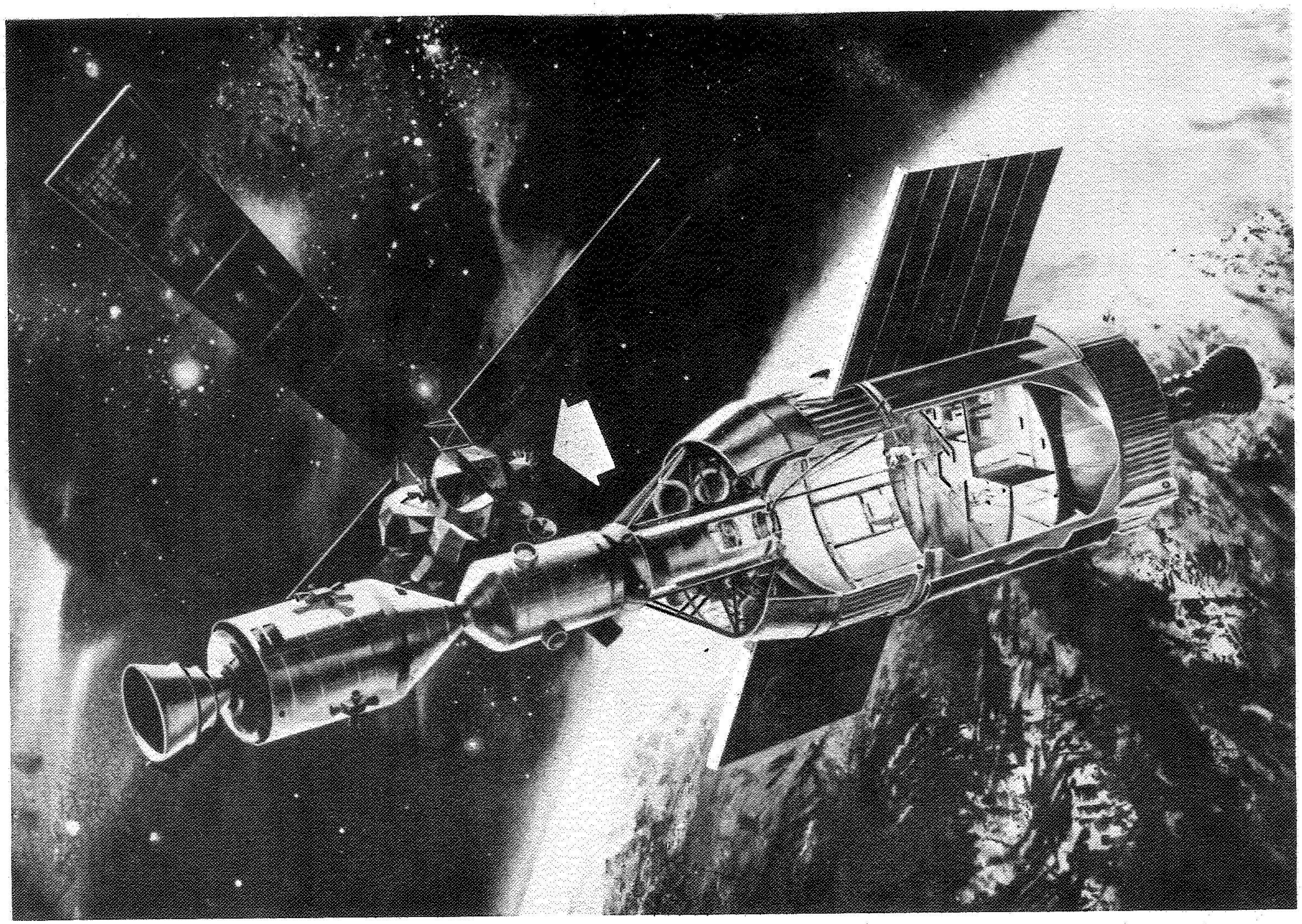

Figure 3.- Relative position of the LM/ATM.

On September 13, MMC presented their concept of activities to be performed in 1969 (post-MSC-3). In addition to continuation of current activities, MMC has proposed a larger role in the experiments area. The recommendation is in review.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY/INSTRUMENTATION LABORATORY (NAS 9-4065)

A contract change authorization (CCA) to the Apollo contract NAS 9-4065 was issued to the Massachusetts Institute of Technology/ Instrumentation Laboratory (MIT/IL) on June 2, 1967. This CCA authorized the basic guidance, navigation, and control systems analysis effort required to support the preparation of AAP onboard mission software. Manpower priority problems were experienced at MIT/IL, however, due to the Apollo workload. A no-cost change to the CCA was negotiated with MIT/IL during the second quarter of CY 1968 to provide extended support to the AAP at a reduced man level. Staffing for the third quarter averaged three men per month.

The MIT/IL analysis effort during the quarter has been concentrated in the following areas:

1. CSM-digital autopilot local vertical modes

2. Combined vehicle guidance and control system evaluation

3. Stabilization of AAP-3/AAP-4 during control moment gyro (CMG) activity

4. Retrofire steering and autopilots

5. Design and verification of unmanned LM system

6. Systems integration of hardware and software

7. Ground systems operation plan (GSOP) outline

8. Command module/orbital assembly RCS orbital translation

A final report is in preparation at MIT/IL and is scheduled for distribution by October 1.

MCDONNELL-DOUGLAS ASTRONAUTICS CORPORATION (NAS 9-6555)

The MSC entered into a fixed-price contract with McDonnell-Douglas Astronautics Corporation (MDAC) on August 19, 1966, to provide NASA MSC with the airlock module. In late 1966, the mission was redefined. Upon completion of redefinition for the airlock, a procurement plan for revising the contract was submitted to NASA Headquarters on June 6, 1967. The plan was approved in November of that year, but the contract document (supplemental agreement (S/A) no. 5) was not approved. The contractor has been working under letter agreements to the basic fixed-price contract.

Current MDAC requirements are to provide: (1) one flight article with spare parts and ground-support equipment, (2) an airlock trainer, (3) a zero-g trainer, (4) a neutral buoyancy trainer, (5) one structural test article, (6) 15 cryogenic tanks, and (7) support documentation and extension studies.

On July 5, 1968, MSC was authorized to extend the existing letter amendment to provide interim contractural coverage from July 1 through December 31, 1968, with a limitation placed on expenditure of funds. By August 15, a new schedule and plan for updating and renegotiating the contract had been developed and coordinated with the contractor. The original contract document was to be supplemented by contract change proposals (CCP's) to reflect the August 1, 1968, base line configuration. A new schedule for evaluation of these CCP's had been prepared by the last week of September.

Significant activities during the quarter include: (1) the structural test article was reviewed and accepted by NASA on September 25, (2) hardware installations are continuing on the MSC trainer, (3) modification kits for the neutral buoyancy trainer were completed and shipped to MSC, (4) only three items remain to be tested in the long-term vacuum testing with scheduled completion dates of November and December 1968, and (5) all radiation tests on materials covered in the basic test request have been completed. In April 1968, MDAC was directed to stop all manufacturing effort on the airlock flight article. The resume-work date for the airlock has been tentatively established as June 1969. An artist's concept of the airlock is shown in figure 4.

On September 10, the Administrator of NASA approved a recommendation that the management responsibility for the airlock module be transferred from MSC to MSFC. Since the date of the transfer has not yet been definitely established, MSC, in conjunction with MSFC, is proceeding with plans to update and definitize the technical and management base lines for the contract. These plans should be completed during the fourth quarter and transfer of management responsibility for the airlock contract will then take place.

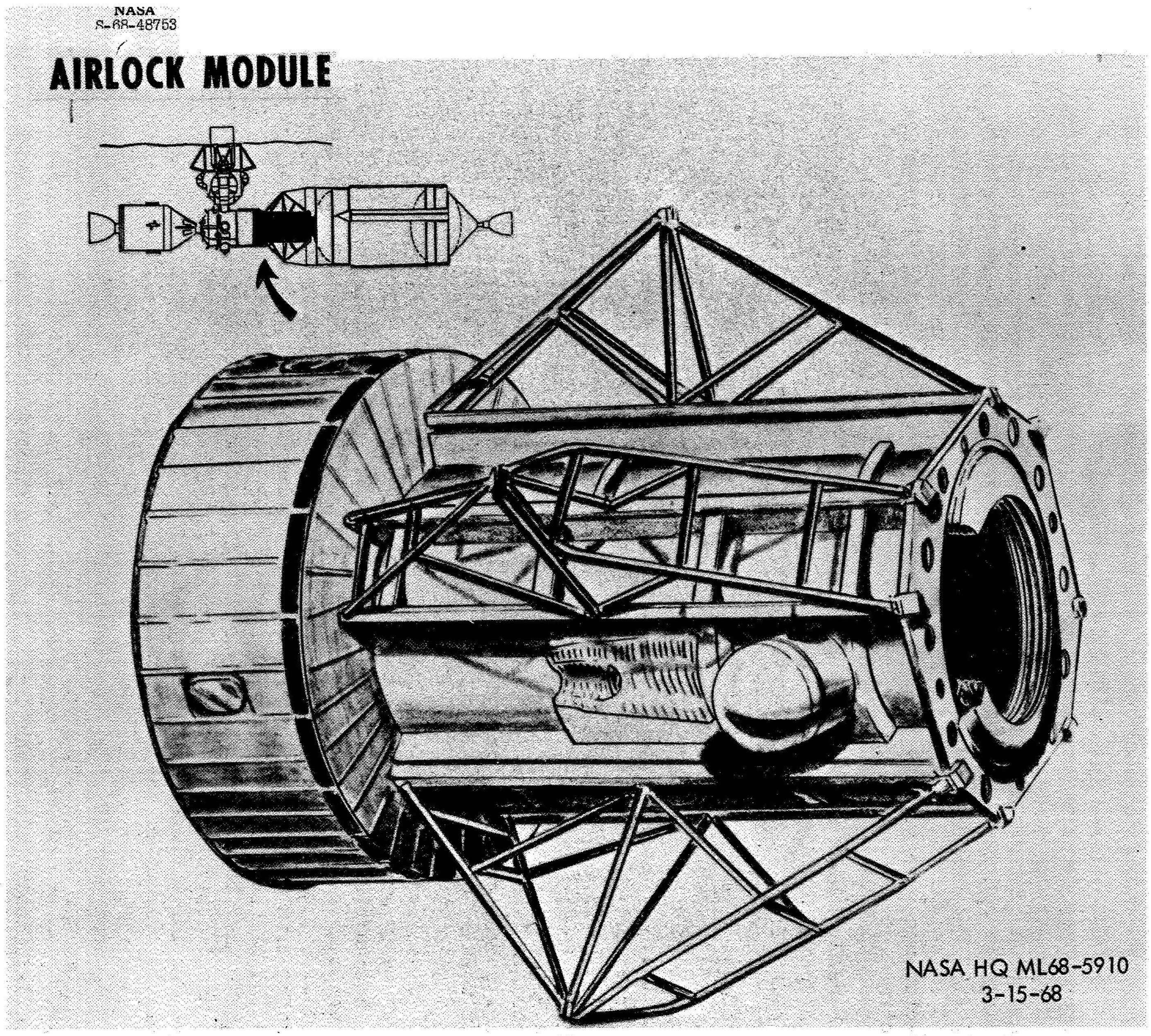

Figure 4.- Artist's concept and relative position of the airlock.

NORTH AMERICAN ROCKWELL (NAS 9-6593)

On November 1, 1966, a level-of-effort contract, "Study of CSM for Advanced Applications," was awarded North American Rockwell (NR) to support the spacecraft definition effort for AAP missions. The contract described the NR effort covering two major areas: (1) mission plans, mission and subsystem analyses, and spacecraft definition for selected AAP flights, and (2) engineering tasks required to support the various phases of future AAP missions. The contract was scheduled for completion by June 30, 1967. Since that time, the contract has been extended through July 31, 1968, by supplemental agreements.

A new contract statement of work (SOW) entitled "Preliminary Design of the CSM Modifications and Associated Support for the Apollo Applications Program" was incorporated into the contract on June 1, 1968, by S/A 9. The SOW described the contractor's total activities through the preliminary design review, which is now scheduled for mid-February 1969. The general areas of deliverable items specified by this SOW are layouts, plans, specifications, supporting data, and mockups. However, the contractor was instructed by the agreement to initially perform only those tasks required to accomplish a preliminary requirements review (PRR) by late July 1968. In pursuit of that objective, the contractor was instructed to (1) establish the AAP mission and system requirements, (2) develop analyses, schematics, and data required to support the associated engineering activities, (3) provide support at the PRR, and (4) prepare and deliver specific documentation. An artist's concept of the CSM is shown in figure 5.

The PRR was conducted at the contractor's facility on July 29 through August 1, 1968. Approximately 115 NASA personnel from MSC, Kennedy Space Center (KSC), MSFC, and Headquarters attended. A total of 232 review item discrepancies (RID's) against the PRR documentation was processed by the review board. The documentation changes resulting from the approved RID's have been incorporated into the contractor documents.

During this quarter, S/A's 10, 11, and 12 were issued extending contractual coverage through September 30, 1968. The original 150-man limitation was retained in accordance with Headquarters decisions. However, in September, Headquarters authorized a controlled manpower buildup in order to accomplish a PDR during February 1969. Supplemental agreement no. 13, effective on September 22, was issued to implement the manpower increase.

Presently, the major contract effort is being devoted to the preparation of the documentation to support the preliminary configuration review (PCR), which is to be conducted at the MSC in mid-October 1968.

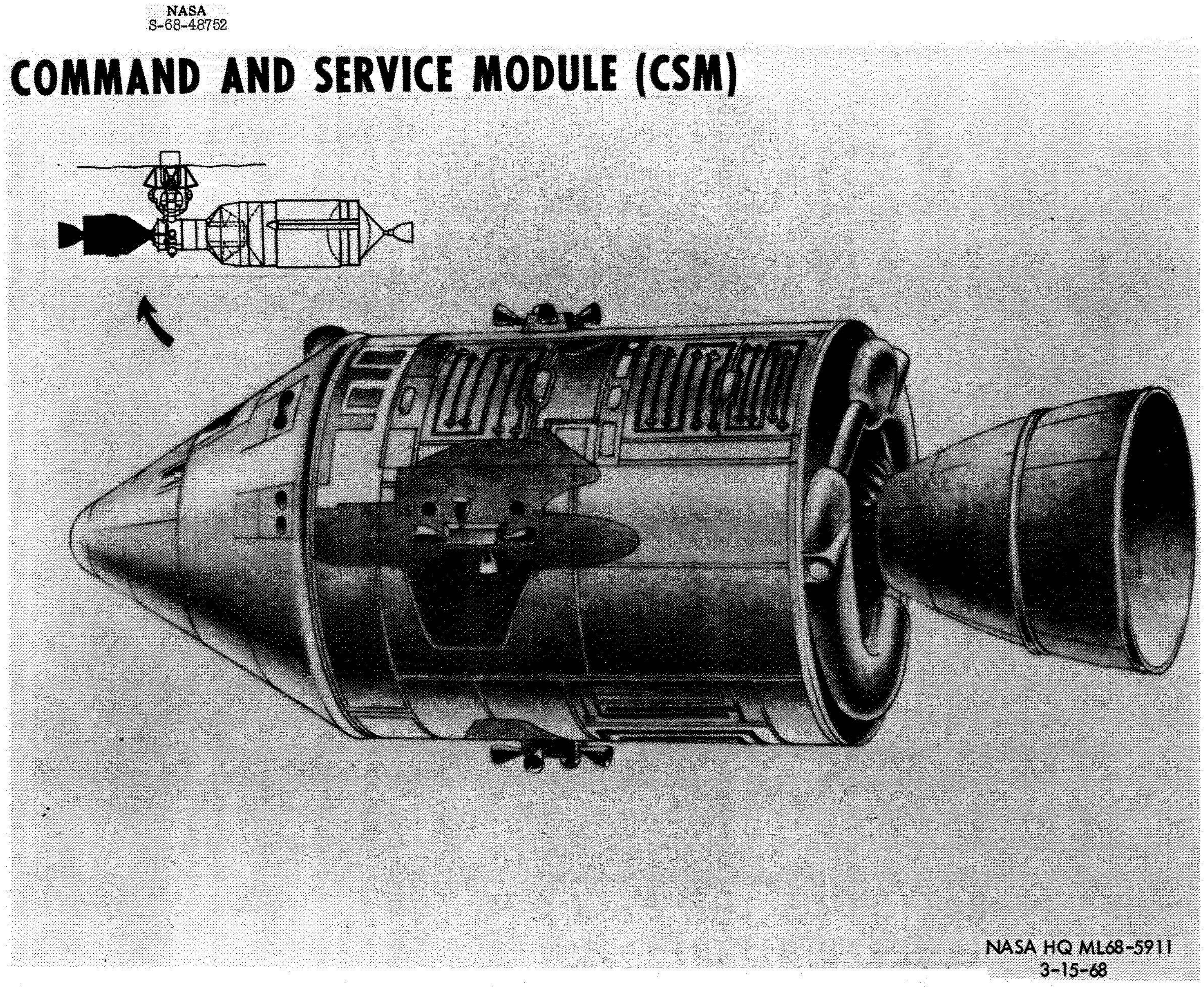

Figure 5.- Artist's concept and relative position of the command and service module.

MISSION PLANNING

During the third quarter, several documents have been prepared in connection with mission planning. A base line reference mission data package for AAP-1/AAP-2, AAP-3A, and AAP-3/AAP-4 was published and distributed in July. The data package was designed to support generation of the base line reference mission (BRM). Current fluctuations within the AAP definition, however, causes much of the data to be of a preliminary nature. Formal updates for the document have not been scheduled, but Change 1 has been approved and published. As the AAP program becomes better defined, this document will be replaced by the Mission Design Data Books.

Comments are being received from the recipients of the Preliminary Base Line Reference Mission for AAP-1/AAP-2, AAP-3A, and AAP-3/AAP-4, which was published in June. These comments are being reviewed for inclusion in the followon publication, the Base Line Reference Mission. A significant change base lined into the BRM is to launch in daylight, land in daylight, and retain a 28-day mission in Mission AAP-1/AAP-2.

The mission requirements document for AAP Missions AAP-1/AAP-2, AAP-3A, and AAP-3/AAP-4 was distributed in July. The document, a joint responsibility of MSC and MSFC, contains information of a general nature. Individual mission requirements and descriptions are covered in the appendixes. The operational experiment requirements for individual missions are published under separate cover but as a part of the mission appendix. Only the appendix for Mission AAP-1/AAP-2 was contained in the original publication since specific schedules for the remaining missions have not been established.

A method for identifying movable items in the CM was defined during the quarter. The identification allows these items to be stripped-out by the computer when calculating inflight mass properties. The first CSM mass properties data tapes have been received and processed. Mass properties is one of the sections in the base line reference mission design data package. It will also be a part of the Mission Design Data Books.

During the quarter, the most pressing problem facing mission planning was how to relieve the predicted overweight payload situation on the AAP missions. A number of meetings between Headquarters, MSC, and MSFC have been held to discuss and resolve this problem. On September 26, the following major items were base lined:

1. Insertion of the AAP-2 workshop into a lower orbit and use of the service module (SM) reaction control system (RCS) for boosting the workshop to the operating altitude. The existing RCS AAP-1 SM tanks

will be loaded to capacity to provide the additional boost. The potential increase in the AAP-2 payload capability is 2700 pounds. However, to allow for the worst Saturn IVB (S-IVB) passivation deficit, 800 pounds of this increase is unavailable.

2. An S-IVB engine selectivity program was adopted. A hot engine could be counted as a payload capability increase of 500 pounds to AAP-2.

3. The orbital assembly base orbit was lowered from 220 to 210 nautical miles. This produces a payload relief of 800 pounds for AAP-2.

4. A 2-1/2 stage insertion for flights AAP-1, AAP-3A, and AAP-3 was provisionally base lined. This technique of CSM insertion into orbit will provide an increase of 2200 pounds of useful CSM payload into orbit. Potentially the scheme increases the payload into orbit by more than 2600 pounds. However, performance reserve and penalties involving both dispersions and low specific impulse could decrease the payload by approximately 300 pounds.

5. A 35° inclination flight plan was adopted to allow a substantial overfly of the United States. This increased overfly is for two purposes:

a. It enables accumulation of basic data for specific American interests, such as a multispectral survey of the United States for the earth resources program.

b. It encourages a more direct American participation in the space program.

6. An approved experiments list was base lined with an associated weight of approximately 2900 pounds.

Another problem is related to both the ascent and return payload stowage of flights AAP-1, AAP-3A, and AAP-3. Studies indicate that a considerable effort will be necessary to define the amount and types of crew equipment, food, et cetera, due to the limited storage volume available in the CM. Initial indications are that the ascent problem is most significant on AAP-3A because of volume. However, both weight and volume on AAP-3 return appear to be significant problems. As a solution to the problem, a series of stowage lists working group meetings have resulted in a definitized AAP-1/AAP-2 stowage list and preliminary drafts for Missions AAP-3A and AAP-3/AAP-4.

A possible southern-hemisphere recovery in Mission AAP-1/AAP-2 was accepted to avoid an incompatibility between mission duration and the assurance of daylight launches and landings. The resulting base line was a 28-day mission with a daylight launch and landing.

An integrated thermal control system was base lined for the airlock/ S-IVB. Although this change increases the weight of the airlock by 110 pounds, it allows a weight reduction of 460 pounds for the S-IVB modifications.

A change to lightweight solar arrays was base lined into the mission. The change will reduce the weight of the S-IVB by approximately 350 pounds, and it will provide a slightly higher power output.

Another significant feature base lined is the unmanned LM-A/ATM rendezvous and docking with the cluster on AAP-3/AAP-4. The following concept has been recommended as an additional part of the base line:

> An unmanned LM-A/ATM rendezvous and dock with the orbital assembly should have the necessary maneuvers performed by the LM-A. The catchup phase of the rendezvous should be ground-command controlled, the terminal rendezvous phase should be controlled automatically by the LM-A computer, and the docking phase should be remote controlled by a crewmember located at a control console within the MDA. The CSM would provide orbital assembly stability for the docking operations.

Figures 6 and 7 illustrate the flight profiles base lined as of September 30, 1968.

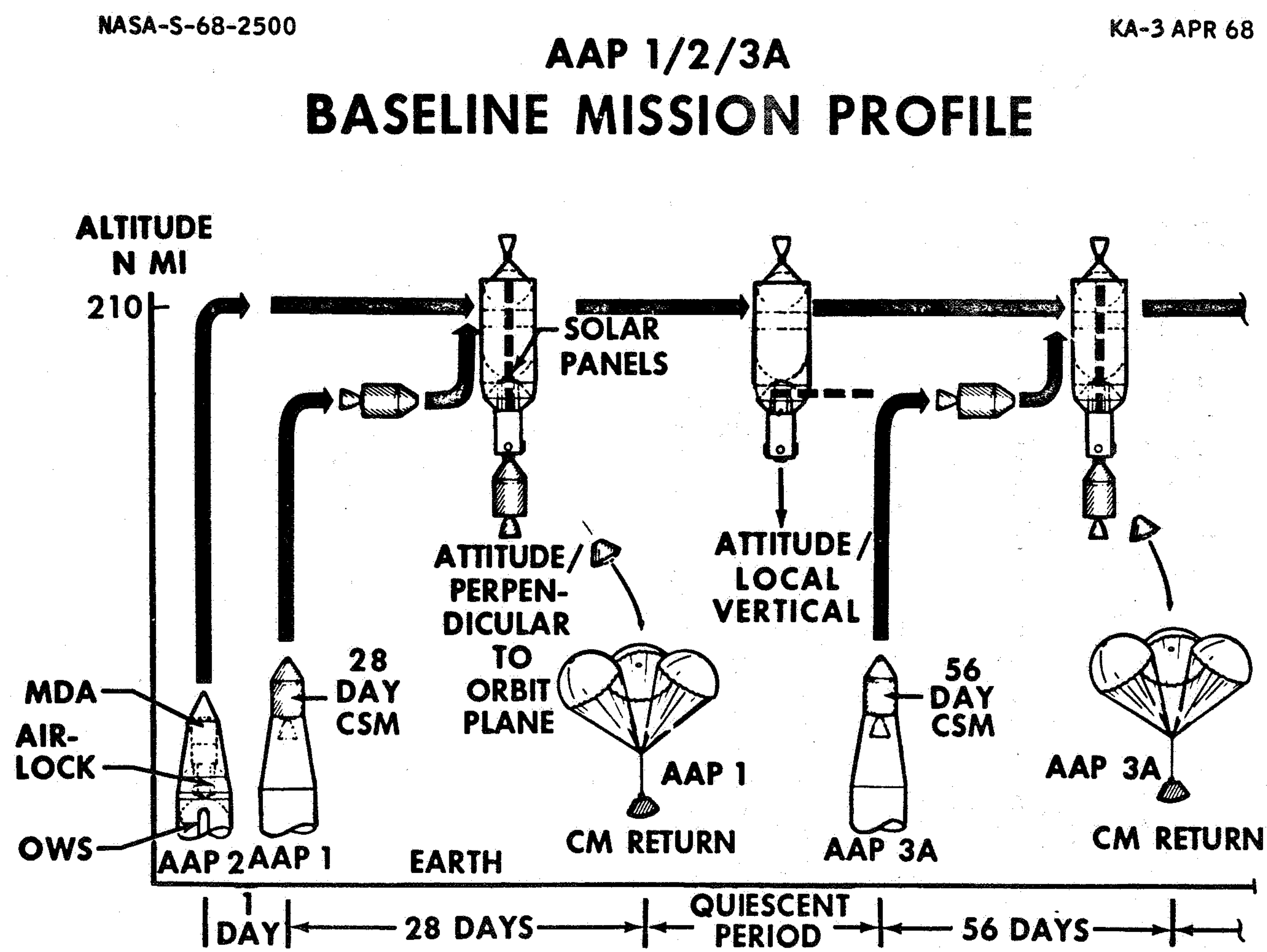

Figure 6.- Flight profile of Missions AAP-1/AAP-2 and AAP-3A.

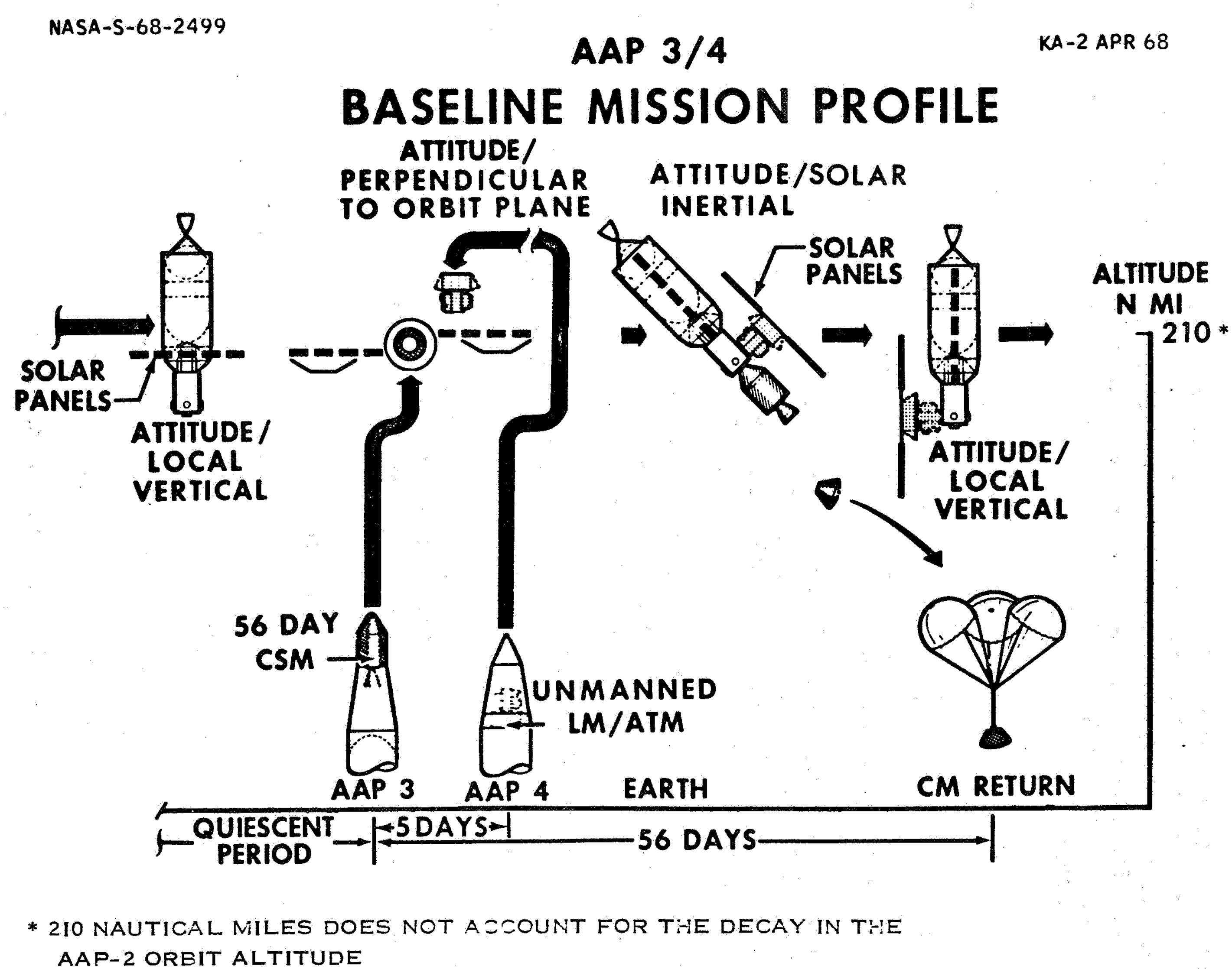

Figure 7.- Flight profile of Mission AAP-3/AAP-4.

EXPERIMENTS

The AAPO is the MSC point of contact for the management of all activity concerned with the planning and implementation of AAP experiments. The major activities in the experiments area during the third quarter were PRR's held for Experiments S061 and M509 and the establishment of a base line experiments list for Mission AAP-1/AAP-2. Highlights during the quarter include:

1. Preparation of a preliminary project development plan for AAP experiments.

2. Review of experiments at the CSM preliminary requirements review held on July 29 through 31. During the meeting, experiment integration requirements were reviewed and updated.

3. Preliminary requirements review of Experiment M509, Astronaut Maneuvering Activity on August 15. The end-item specification (EIS) and the statement of work (SOW) were reviewed. Eighty-nine RID's were dispositioned by the board.

4. Preliminary requirements review of Experiment S061, Potato Respiration on September 5. The EIS and the SOW were reviewed. All of the 61 RID's written at the review were dispositioned by the board.

5. Review of the preliminary copies of the Experiment Functional/Schedule Analysis. The analysis will be used to establish need dates for experiment hardware.

6. Review of experiments base line at MSFC on September 26. During the review the following list of experiments was provisionally base lined for the AAP-1/AAP-2 mission (the list has not yet been approved by Headquarters):

S015	Zero-g Single Human Cell
D008	Radiation in Spacecraft
M487	Habitability/Crew Quarters
M051	Cardiovascular Function Assessment
M052	Bone and Muscle Changes
M056	Non-Gravimetric Mass Measurement
M058	Human Mass Measurement Device

M053	Human Vestibular Function
M018	Vectorcardiogram
M055	Time and Motion Study
D019	Suit Donning and Sleep Station Evaluation
D020	Alternate Restraints Evaluation
T025	Coronagraph Contamination Measurement
T027	ATM Contamination Measurement
M509	Astronaut Maneuvering Equipment
M508	Astronaut EVA Hardware Evaluation
T020	Jet Shoes
D021	Expandable Airlock Technology
S065	Multiband Terrain Photography
T003	In-flight Nephelometer
M479	Zero-g Flammability
T004	Frog Otolith Function
T021	Meteoroid Velocity
T017	Meteoroid Impact and Erosion
D022	Expandable Structures for Recovery
S019	Ultraviolet Stellar Astronomy
S101	Multispectral Terrain Photography

The following list indicates experiments presently scheduled for Mission AAP-3A:

[a]M402R	Orbital Workshop
[a]M479R	Zero-g Flammability
[a]M487R	Habitability/Crew Quarters
[a]M493R	Electron Beam Welding
[a]M018R	Vectorcardiogram
[a]M050R	Metabolic Activities
[a]M051R	Cardiovascular Function Assessment
[a]M052R	Bone and Muscle Change
[a]M053R	Human Vestibular Function
[a]M055R	Time and Motion Study
[a]M056R	Nongravimetric Mass Measurement
[a]M058R	Human Mass Measurement Device
[a]M509R	Astronaut Maneuvering Unit
[a]T018R	Precision Optical Tracking
T021	Meteoroid Velocity
[a]S018RC	Micrometeorite Collection

[a]The R designates that the experiment is to be performed on AAP-1/AAP-2 and is scheduled for reactivation and reuse on AAP-3A. The RC designates that the experiment is to be initiated on AAP-1/AAP-2 and is scheduled for completion on AAP-3A.

[a]S019R	Ultraviolet Stellar Astronomy
[a]S020R	Ultraviolet/X-ray Solar Photography
[a]S027R	Galactic X-ray Mapping
S063	Ultraviolet Airglow Horizon Photography
[a]S065R	Multiband Terrain Photography (Hand Held)
S072	Circadian Rhythm - Vinegar Fly
S073	Gegenschein/Zodiacal Light
S028	Dim Light Photography

The following list indicates experiments presently scheduled for Mission AAP-3/AAP-4:

[b]M402RD	Orbital Workshop
[b]M487RD	Habitability/Crew Quarters
S061	Potato Respiration
[b]M051RD	Cardiovascular Function Assessment
[b]M050RD	Metabolic Activity
[b]M058RD	Human Mass Measurement Device
[b]M052RD	Bone and Muscle Changes
[b]M056RD	Nongravimetric Mass Measurement

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[a]The R designates that the experiment is to be performed on AAP-1/AAP-2 and is scheduled for reactivation and reuse on AAP-3A. The RC designates that the experiment is to be initiated on AAP-1/AAP-2 and is scheduled for completion on AAP-3A.

[b]The RD in experiment numbers designates experiments to be performed on Mission AAP-1/AAP-2 and scheduled for reactivation and reuse on Mission AAP-3/AAP-4.

[b]M055RD	Time and Motion Study
[b]M053RD	Human Vestibular Function
[b]M018RD	Vectorcardiogram
T018	Precision Optical Tracking
S083	Ultraviolet Scanning Spectrometer
S082	Ultraviolet Spectrograph/Heliograph
S052	White Light Coronagraph
S054	X-ray Spectrographic Telescope
S056	Dual X-ray Telescope
T018	Precision Optical Tracking

Experiment M439, Star/Horizon Automatic Tracking, has not yet been assigned to a particular mission.

[b]The RD in experiment numbers designates experiments to be performed on Mission AAP-1/AAP-2 and scheduled for reactivation and reuse on Mission AAP-3/AAP-4.

SYSTEMS

STRUCTURAL AND MECHANICAL

Airlock

The airlock structural assembly provides the means for attaching the multiple docking adapter (MDA) to the S-IVB and for mounting various functional systems. The airlock also provides a support attachment to the spacecraft-lunar module adapter (SLA). The airlock flight article continues on the manufacturing hold established in April 1968. However, the structural test article was accepted from the contractor on September 25. The problem of welding which involved the bellows that connect the workshop and the airlock was resolved during the quarter by simplifying the design and eliminating weld joints.

Lunar Module A

The LM to be used in the AAP LM/ATM application will consist of the ascent stage of the Apollo LM vehicle. The two units, the LM and the ATM, will be mated at KSC. Significant changes to the LM during the third quarter were the addition of 6 inches to the crew provisions service module to accommodate film stowage and the decision to replace the LM-A probe with a drogue. Otherwise, the LM-A continues in the preliminary design phase.

The ATM PDR was held on September 24. Two of the RID's written at the review could lead to design changes. One RID provided for a space-ground television system for transmission from the ATM television monitor and S-IVB television camera. Another RID imposed a continuous duty cycle for the ATM tape recorder. These RID's had not been resolved at the end of the quarter.

One of the most significant pacing items in the LM/ATM program now appears to be the necessity for a LM-A structural test article to support the MSFC ATM vibration test program as well as LM-A development tests. Since a suitable Apollo test article cannot be made available and since the lead time to build a new ascent structure is 18 months, the most feasible approach is to convert an Apollo LM ascent stage into a LM-A structural test article. A replacement ascent stage would be built on a routine schedule basis to be returned to Apollo at the end of the current production line.

Spacecraft-Lunar Module Adapter

The SLA is a standard Apollo Block II configuration. No changes or problem areas have developed during the quarter. Recently calculated internal loads for the SLA indicate that loads for the AAP-2 flight are 20 percent less than those imposed by the Apollo missions. A formal stress analysis has not yet been completed.

Command and Service Module

The structural configuration of the AAP CSM is essentially the Apollo Block II CSM with only minor modifications. No significant changes or problems have occurred during the quarter. The preliminary requirements review for the CSM was held on July 29 through 31. The most significant RID written in the structures area was a requirement to rewrite the environmental design criteria. This task should be completed during the fourth quarter.

PROPULSION SYSTEMS

Service Propulsion System

A preliminary requirements review was conducted on the service propulsion system (SPS) on July 29 through 31. Two RID's were written against the system; one involved correction of data and has been disposed of. The second requested an onboard propellant gaging system capable of providing propellant quantity measurements to the crew during zero gravity. A study is currently in progress to determine the impact of providing the required information to the crew.

Before the PRR, a pressure/volume/temperature leak detection approach had been planned with information being provided to the ground for monitoring. With the completion of the PRR, NR is proceeding to define and establish the design in greater detail in support of the PDR. It is expected that emphasis will be placed on thermal control, modification of plumbing, and determining requirements for system component modification dictated by current Apollo system compatibility tests.

Service Module Reaction Control Subsystem

A PRR was conducted on the service module reaction control subsystem on July 29 through 31. Six RID's were written against the subsystem. Five of the RID's were corrections of a minor nature and have been completed. A study is currently in progress to resolve the open RID, which is concerned with the manner and amount of RCS propellant to be reserved for deorbit.

The requirements for the subsystem have been established and emphasis is now on refining the preliminary design for the PDR. The basic configuration has been defined. Specific components, such as the propellant isolation valve and propellant accumulator, which requires or may require redesign, are being studied.

Thermal control for the propellant modules and lines appears to be the major problem on the RCS. Thermal analysis is in progress and this problem should be resolved within the next 6 months.

Lunar Module Reaction Control System

The LM-A RCS preliminary design has been completed in preparation for the PDR. Configuration and plumbing design were established during the quarter. Both preliminary design and PDR documentation has been completed. The MSC is currently reviewing this information in preparation for the PDR.

The approach for deactivating the LM RCS after LM docking with the cluster has not been defined. It appears that squib valves will be required to vent the residual helium pressure since both expected propellant tank temperature profiles during the mission and fracture mechanics analysis indicate a possibility that safe pressure limits may be exceeded for the tanks.

CREW STATION SYSTEM

Flights AAP-1, AAP-3A, and AAP-3

A PRR for the three AAP command and service modules was held on July 29 through 31. The requirement to maintain the land-landing capability for end-of-mission return was rescinded by the PRR board. This decision provides a much greater command module volume available for return payload. New launch and return payload studies were initiated and are expected to be complete for the preliminary base line review (PBR) in mid-October.

Flight AAP-2

A major revision of the crew station arrangement of the MDA/airlock/S-IVB workshop has been dictated by new requirements and guidelines.

Control and display requirements for the vehicles have progressed through new integrated layouts. The ATM extravehicular activity (EVA) work stations were relocated to place them adjacent to the LM-A hatch since most EVA activity will be from that hatch. Manual and/or simplified devices for crew and cargo transfer for ATM film retrieval instead of more complicated devices such as the serpentuator were base lined. The crew provisions stowage module was redesigned to provide more internal storage. The internal height was increased to 27 inches to allow proper orientation of the NRL and AS&E packages. Otherwise, experiment arrangement and habitability equipment remain largely undefined.

Flight AAP-4

The PDR of the Apollo telescope mount was held at MSFC late in the quarter. The preliminary design of the ATM controls and displays was basically unchanged from the one recommended by the Controls and Displays Ad Hoc Working Group last May. The preliminary design of the EVA support equipment was basically conceptual with much detail remaining to be defined before operational simulation and evaluation can be accomplished.

ELECTRICAL POWER SYSTEM

Cluster Load Profile

Most of the individual equipment loads have now been defined for the cluster load profile. Determination of accurate power profiles is still limited by incomplete definition of astronaut activity timelines and concurrent orbital conditions. However, analyses have been made of the electrical loads which would exist under various operational modes such as EVA, pressurization, experimentation in the orbital assembly, and thermal loads imposed by orbital orientation. These analyses indicate that loads due to required equipments can be selected, and sufficient unnecessary equipments can be turned off so that the base line 1200-square foot solar array/8 power conditioning groups/A-C fuel cell system will be sufficient to support all of the presently planned mission activities. This conclusion is based upon use of the integrated cluster ECS, which requires a maximum of 750 watts.

Airlock

A study was performed to determine the advisability of reducing the number of power conditioning groups from eight to six in order to reduce AAP-2 weight. The study indicated that all of the power conditioning groups should be retained since any reduction would limit the utilization of the S-IVB array and would excessively decrease the reliability of the airlock electrical power system (EPS).

Preparation of an overall cluster electrical schematic was initiated during the quarter to show the capability for switching the cluster power sources to the various distribution buses and the interconnecting impedance.

Command and Service Module

Monthly AAP-1/AAP-2 power profiles submissions have continued. The latest submission shows a 4300-watt peak load during rendezvous maneuvers and a 3700-watt peak during the EVA. The average mission load has been reduced to 2000 watts. Investigations have been initiated to determine the best means to refine the computer program to more accurately account for the EPS thermal loop characteristics and provide the capability for predicting off-nominal performance. The capability to provide real-time mission support is also being considered.

The Allis-Chalmers fuel cell has a potential problem in the thermal area which is related to "no vent" requirements. Since venting does occur when the radiator outlet temperature exceeds approximately 110° to 115° F, the "no vent" requirement would be violated during those periods of excessive temperatures. Such a situation could require some redesign of the fuel cell.

Lunar Module

A study conducted during the quarter has indicated that the ATM control and display console could be provided with the required conditioned power by using two LM lighting control assemblies.

The overall LM power requirement was reduced from 34 to 18 watts by converting from white to more effective green status lights.

A CSM manual control will be located in the MDA for rendezvousing the unmanned LM.

Cluster Lighting

As indicated in the preceding paragraph, the ATM control and display status lights were changed from white to green.

The orbital assembly running lights will be changed to all white since CSM clocking from this orientation is not a requirement. The white light will also provide better overall illumination.

A requirement has been established to turn acquisition lights on and off by using the digital command system commanded timer. Direct command from the CSM would require qualification of the necessary equipment and will not be used.

Illumination of the airlock instrument panel will continue to be via floodlighting. This scheme has the optimum combination of lighting level, weight, cost, and volume of fixture.

To assure emergency egress from the orbital assembly, an emergency lighting system powered from the regulated bus via series-parallel diodes has been proposed.

Pyrotechnics

Preliminary investigations indicate that redevelopment and/or requalification of some of the CSM pyrotechnic devices may be required because of possible sublimation of the RDX material. Since fabrication of all CSM pyrotechnics has terminated, schedule constraints may be encountered if this effort proves necessary.

Review of the circuitry associated with CSM pyrotechnics has led to the decision to use main bus batteries as backup for the primary pyrotechnic batteries.

A modified landing gear uplock cutter will be used to release the LM radar antenna.

GUIDANCE AND CONTROL

Command and Service Module

During the quarter, additional studies and laboratory tests for the unmanned LM rendezvous were conducted. It was found that sextant focus at short range (as low as 500 feet) will not interfere with navigation sightings and that LM target lights in the vicinity of the docking ring will allow visual attitude accuracy of approximately 10°. This accuracy is adequate for visual techniques in the manual control mode intended for the short range control required in braking maneuvers. A ground rules and analysis model for current error analysis during remote rendezvous has been established. The control moment gyro desaturation study indicates that there should be no fuel penalty problem with nonorthogonal indexing, particularly when the translational pair jet logic is used.

The North American Rockwell Corporation completed and submitted a complete data package on their unmanned rendezvous and docking studies conducted to date. The package included a performance analysis of using 2-1/2 stages for orbiting. The analysis was conducted to determine the trajectory performance improvement which results if an instrument-unit update of the command module computer is performed at S-IVB cut-off one-half of an orbit after completion of the SPS burn. Remaining studies in this area involve: (1) feasibility of implementing the instrument-unit update, (2) hardware requirements to implement the update, (3) propellant and payload savings resulting from an update, (4) adequacy of existing steering equations for the 2-1/2 stage SPS burn, (5) command module computer software changes required, and (6) effect of improved prelaunch alinement of the inertial maneuvering unit upon 2-1/2 stage performance.

A recommendation made in the package is that the LM-A abort guidance system be used as a backup to the primary guidance system to provide an increase in system reliability. The recommendation is still under study.

Lunar Module/Apollo Telescope Mount

Performance analysis of the primary navigation guidance system and of the abort guidance system has been completed. A preliminary draft of the P&I specifications to formally document basic interface requirements and to identify related individual ICD's has been submitted for review.

A PDR was held in the last week of September. There were 15 RID's submitted on the LM/ATM guidance and control systems. The RID's were in the areas of peripheral communication backup systems, instabilities, crew procedures, and thermal protection for components. The RID's were left open as action items. In the meantime, the contractor is proceeding with final design in preparation for the PCR.

Long-lead time hardware items will have no impact on the program since they have already been procured and are classified as GFE.

Workshop Attitude Control System

The Workshop Attitude Control System Working Group Committee is continuing their efforts to resolve the problems of adequate power supply, individual thruster disable capability, ground command requirements, and control and display panel design.

COMMUNICATIONS AND INSTRUMENTATION SYSTEMS

During the third quarter, communications and instrumentation efforts were concentrated on completion of conceptual design. Unmanned rendezvous and remote-controlled docking of the LM/ATM with the S-IVB workshop MDA were base lined. These concepts, to be reflected in the PDR's, are:

1. Mainline Apollo rendezvous radar and vhf ranging systems will be required, with minor changes.

2. A new vhf command link will be required between the CM and the LM-A with a new command processor in the CM. The processor will operate in conjunction with function switches, hand controllers, and other hardware to permit remote attitude and translation control of the unmanned LM-A.

Caution and warning system design criteria were developed during the quarter, and telemetry and command system parameter selection criteria are in the process of being developed.

Major problems have been a lack of technical manpower requested to support the program, preempted priorities on developmental testing, and an exceeded capability of real-time computer complex facilities (approximately 1200 commands have been identified for the AAP-3/AAP-4 mission).

ENVIRONMENTAL CONTROL SYSTEM

Airlock Module

The significant activity on the airlock environmental control system during the third quarter was evaluation and recommendations for potential system changes. The recommendations made are:

1. Addition of an oxygen accumulator subsystem to the airlock gas distribution system.

2. Replacement of the lithium hydroxide/molecular sieve system with a redundant molecular sieve system.

3. Incorporation of an integrated thermal control system for the AAP-2 vehicle.

A major change in the ECS was deletion of the atmosphere revitalization section (ARS) from the ECS. The ARS is not required since the

LM/ATM rendezvous and dock will be unmanned. The deletion will also provide more room for the crew at the ATM control and display console.

Command and Service Module

The most significant activity during the quarter associated with the CSM ECS was completion of the radiator system studies. The use of a modified Block II ECS radiator system with ethylene glycol as the coolant fluid was the system base lined. A major problem of SM thermal control was also solved during the quarter. The solution base lined provides that heat will be added to the SPS and RCS components by electric heaters in combination with changes in insulation and coatings; these changes will enable component temperatures to be maintained within the specified limits.

Lunar Module

The basic change in the lunar module was removal of the suit circuit (190 packages) from the ascent stage. The removal will provide greater cabin-free volume and less spacecraft weight.